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FLORA OF BROWN SEAWEED FROM PAKISTAN (PART-ECTOCARPALES)

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ABSTRACT: The brown seaweeds grow luxuriantly at Karachi coast. The seaweeds are recognized for their utilization on commercial scale hence requires to accurate and proper identification. This attempt has been taken to establish flora of the region for identification of seaweed by scientific scholar and research fellows. Initially the most dominant seaweeds i.e. brown algae of Pakistan coast have been classified along with description and drawing.

KEYWORDS: Brown seaweed, Karachi coast, Part-Ectocarpales.

INTRODUCTION

The coastline of Pakistan is about 1000 km situated at the subtropics of cancer, divisible into the eastern coast of Sindh and western coast of Balochistan (including Makran Coast) (Fig.1). Along the coast of Sindh the shelf is flat and soft bottomed. Karachi is situated at northern most part of the Arabian Sea. It includes number of beaches, numerous islands and mangrove swamps. The coastal belt around Manora, Sandspit, Hawkesbay, Buleji, Paradise Point, Pacha, Nathiagali and Cape Monze display clear water with a variety of marine organisms. There is a massive growth of seaweeds, which are present at these beaches either as drift material or attached with rocks or growing in water pools (Shameel & Tanaka 1992).

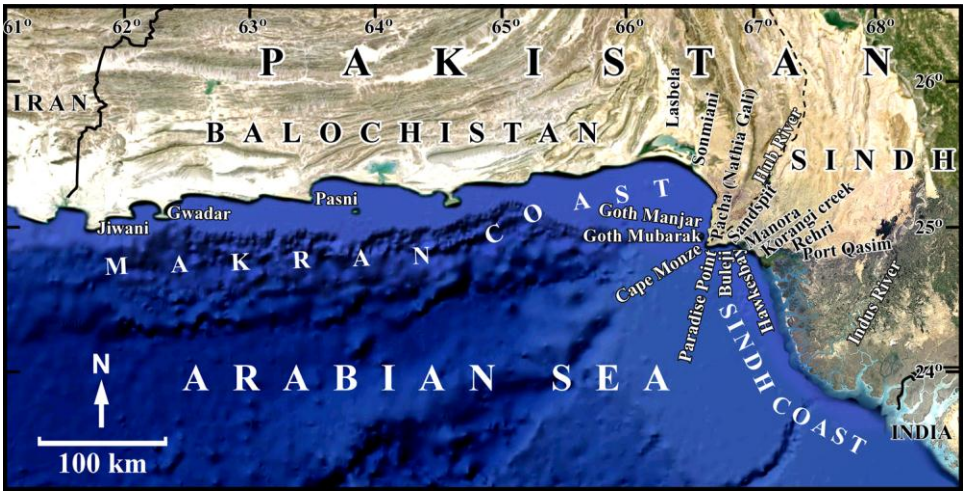

Fig. 1. Map of collection sites.

Børgesen (1934) was the first phycologist, who started the taxonomic work on marine algae and has provided a long list including several brown algae. Anand (1940) has conducted a thorough investigation on the taxonomy of Chlorophycota collected from the Karachi coast. The present knowledge about taxonomy of brown algae from the coast of Karachi, though fragmentary, is due to the efforts of Prof. M. Nizamuddin and his students. Nizamuddin & Saifullah (1967) have investigated the genus *Dictyopteris Lamouroux* from Karachi coast, which was supplemented by Khatoon & Begum (1990). Nizamuddin & Gessner (1970) investigated the seaweeds collected from northern part of the Arabian Sea and Persian Gulf including several species of brown algae from the coast of Karachi. Nizamuddin & Farooqi (1968) described in detail the morphology and anatomy of *Endarachne binghamiae* J. Agardh from Karachi coast, while the taxonomy of other members of Scytosiphonales was studied by Nizamuddin & Begum (1978) and was supplemented by Begum & Khatoon (1992).

Nizamuddin (1975) initially described *Dicyota hauckiana* Nizamuddin and then conducted a detailed taxonomic investigation on other members of Dictyotales (Nizamuddin & Perveen 1986). Although, *Padina pavonica* (L.) Thivy was studied by Zahid et al. (1983) but further information on Dictyotales was added by Begum & Khatoon (1993). Later on, Nizamuddin & Aisha (1996) described in detail the morphology and anatomy of Stypopodium (Kützing) J. Agardh including the specimens from Karachi coast. Taxonomy of the Ectocarpales was investigated by Begum & Khatoon (1992b) and Shaikh & Shameel (1995) described the taxonomy of 14 commonly occurring brown algae of Karachi coast. Afaq-Husain & Shameel (1999) studied in detail the structure and reproduction of the populations of *Cystoseira indica* (Thivy et Doshi) Mairh from entire coast of Pakistan including Karachi, which was briefly redescribed by Gul & Nizamuddin (2007) from Karachi coast. Only recently a detailed anatomical study was carried out on several brown algae from the coast of Karachi by Abbas & Shameel (2008, 2009).

Salim (1965) has presented an ecological survey by describing the distribution of various classes of algae along the coast of Karachi. Saifullah (1973) conducted a preliminary survey of the standing crop of seaweeds growing along the coast of Buleji near Karachi including brown algae as well as Qari & Qasim (1988) investigated seasonal changes in the standing crop of intertidal seaweeds. Begum & Khatoon (1988) described the ecological distribution of Phaeophycota from the coast of Karachi. Shameel & Tanaka (1992) presented habitat ecology of all the classes of marine algae from the coast and inshore waters of Pakistan including brown seaweeds occurring along the coast of Karachi. Later on several surveys were carried out on the community structure and species composition of marine algae including brown seaweeds from Karachi and neighbouring coastal areas (Hameed et al. 2000a, b, 2001).

Apart from Karachi a few studies have been made on the habitat ecology and distribution of brown algae from the neighbouring coast of Lasbela (Shameel 1987, Shameel & Afaq-Husain (1987), Shameel et al. 1989) and further apart from the coast of Makran i.e. western coast of Balochistan (Shameel et al. 1996, 2000, Shameel 2000, 2001b). From the foregoing literature survey, it becomes apparent that most of the above mentioned studies are ecological surveys and very little work has been done on the taxonomy of brown seaweeds from the coast of Karachi. Therefore, the present study has

been undertaken to investigate in detail the species of brown algae occurring along the coast of Karachi for a better understanding of their morphology, anatomy, growth and reproduction.

MATERIALS AND METHOD

1. **Collection Sites:**

Species of brown seaweeds were collected during 1989 and 1995 at various times of seasons twice a month usually from different localities *viz.* Manora, Sandspit, Hawkesbay, Buleji, Paradise Point, Pacha, Nathiagali, Cape Monze in the northernmost part of the Arabian Sea. The details of collection sites are given below.

(i) Manora:

The area is mostly covered by rocks but sandy beaches also beautify this semi-Island. Rocky area is very old and contains several permanent pools having rocky and sandy bottoms. Flora of this area is stable since a very long period and presents a large list of brown and green seaweeds along with some red seaweed.

(ii) Sandspit:

The part near the seashore has a small rocky but a very long sandy beach. Present collection included material obtained from rocky ledges and also drifted specimen. This part of the coast shows rich flora of brown and green seaweeds with some red seaweeds.

(iii) Hawkesbay:

It has a large sandy shore interrupted by rocky ledges having muddy and rocky pools, which provide good substrate for phaeophycotean algae. The coastal region near the shore is mostly occupied by channels. Most dominating flora of this area consists of brown seaweeds and some members of Chlorophycota and Rhodophycota.

(iv) Buleji:

Rocky shore, having deep to shallow rocky pools on the ledge that can be easily distinguished into upper, mid and lower littoral zones. These zones exhibit the growth of a variety of seaweeds, dominated by phaeophycotean members along with the members of chlorophycotian and rhodophycotian members.

(v) Paradise Point:

This is most beautiful locality of Karachi coast, characterized by a rocky ledge with a natural cleavage at the centre. The region is mostly covered with rocks forming slopes towards the sea, on the right of cleaved rocky ledge holes are formed at different intervals. Here flora is mostly dominated by rhodophycotian members along with some members of the green and brown algae.

(vi) Pacha:

It is a shore interrupted by rocky ledges having rocky pools, which provide good substrate for phaeophycotean algae. The coastal region near the shore is mostly occupied by channels. Most dominating flora of this area consists of brown seaweeds and some members of Chlorophycota and Rhodophycota.

(vii) Nathiagali:

It is a beautiful sandy beach between mountains and the sea. Some part of the beach has rocky ledges containing deep to shallow rocky pools with sandy bottom. Here flora shows luxuriant growth of brown algae alongwith some red algae.

(viii) Cape Monze:

It has a large sandy shore interrupted by rocky ledges having muddy and rocky pools, which provide good substrate for phaeophycotean algae. The coastal region near the shore is mostly occupied by channels. Most dominating flora of this area consists of brown seaweeds and some members of Chlorophycota and Rhodophycota.

2. Collection of Algal Materials:

a. Algal species has been found in different groups: i) Epilimnion, ii) metalimnion, iii) hypolimnion, iv) epiphytic, v) epilithic, vi) epizoic

The algal samples were collected from different habitats by the various methods e.g:

i.**Epiphytic samples:** Epiphytic algal samples were collected with the help of pippet from aquatic plants and by crushing in polythene bag along with little quantity of water. The crushed material were fixed in formalin.

Filamentous algae are collected with help of Forceps.

Macro-algae and aquatic plants are picked up with hands from different habitat of water body.

ii. **Epilithic flora:** Epilithic flora are collected with the help of tooth brush, knife from rocks.

RESULTS AND DISCUSSION

Algae are those organisms, which manufacture their own food material and bear no sterile layer of jacket cells around their reproductive organs, both sexual as well as asexual. They exhibit no embryogenesis, so that their ova leave the body of mother individual either immediately after fertilization or sometimes prior to fertilization.

Diversity of seaweed species and their habitats at Karachi were given in Table. 1, Figs. 2 and 3.

Table 1. Diversity of seaweed species at Karachi.

Phyla	Classes	Orders	Families	Genera	Species
Cyanophycota	3	4	12	25	55
Chlorophycota	2	8	10	18	76
Vaucheriophycota	1	1	1	1	4
Phaeophycota	3	7	10	25	65
Porphyridiophycota	1	1	1	3	3
Rhodophycota	3	13	24	48	85
Total	13	34	58	120	288

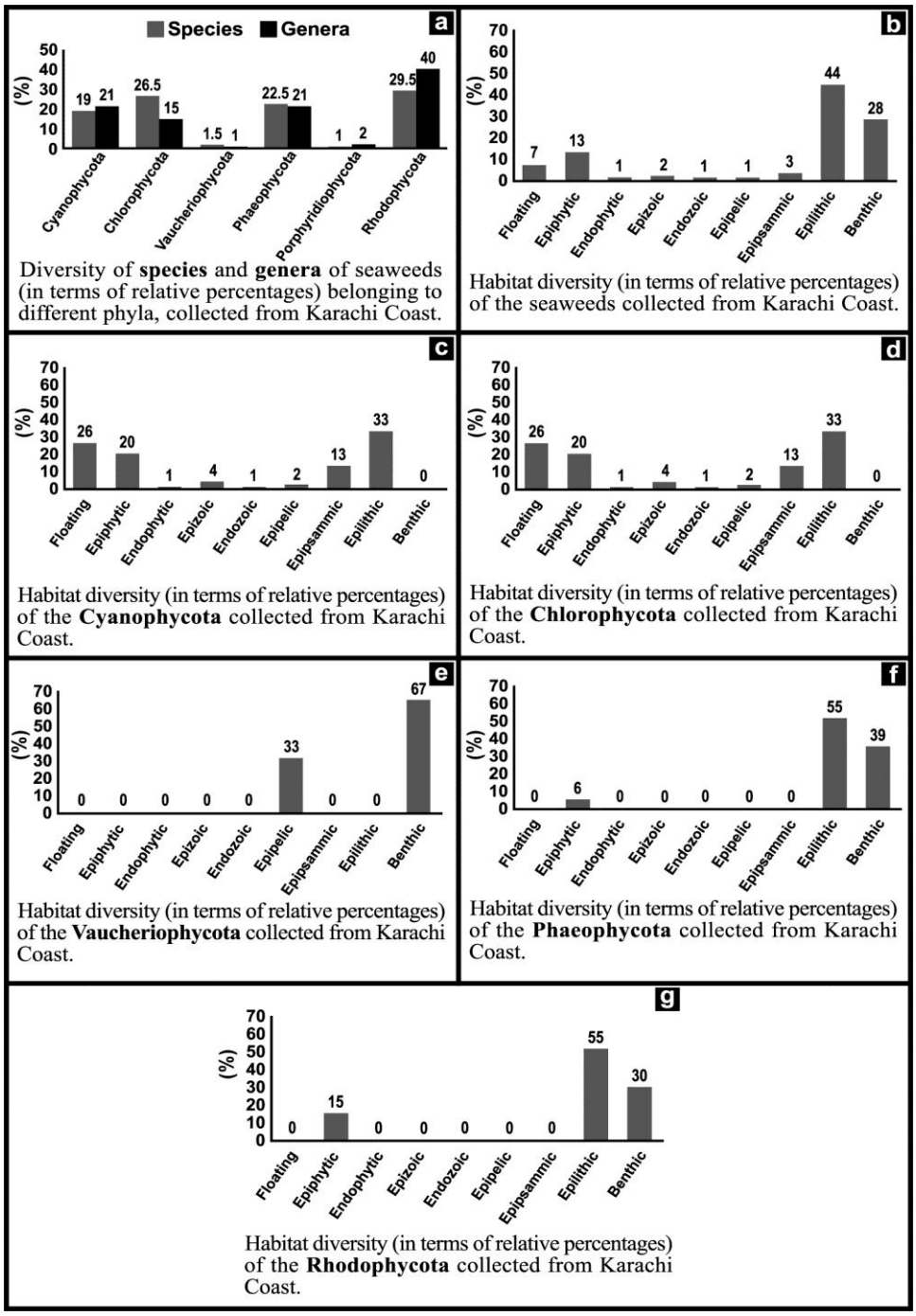

Fig. 2. a-g, Diversity of seaweeds and their habitat (in terms of relative percentages) belonging to different phyla, collected from Karachi coast.

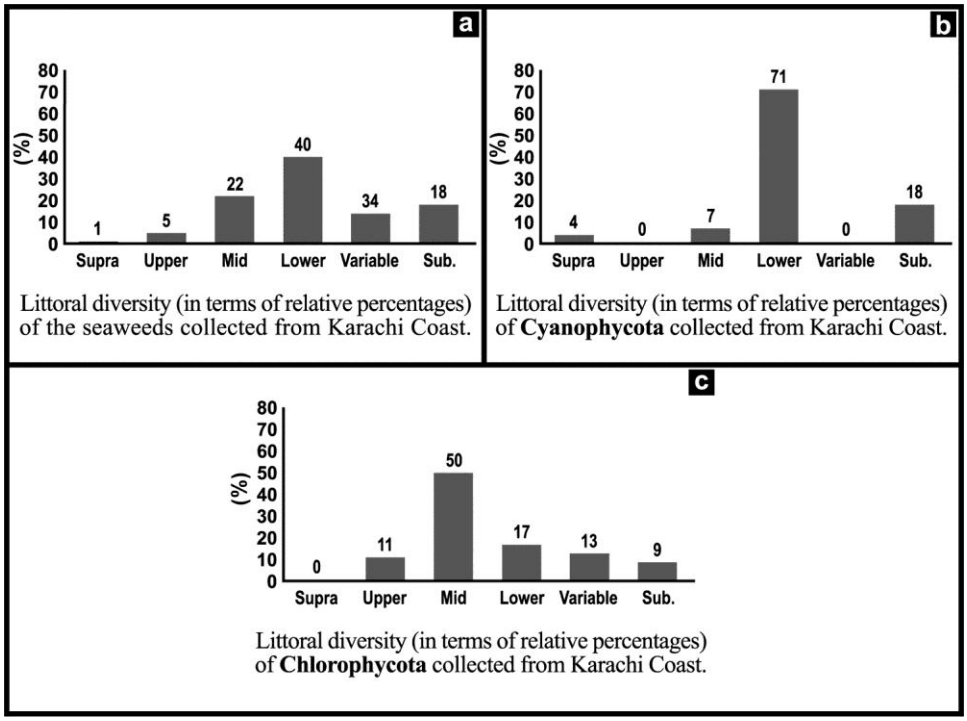

Fig. 3. a-c, Littoral diversity (in terms of relative percentages) of the seaweeds collected from Karachi coast.

The present work of classification is a peer need of recent days more than before. The application of seaweed on commercial pharmaceutical and organic products make it necessary to have very clear, easy and reliable classification which can benefits for all scholar. The present research describes all individual of seaweeds found along the coast of Pakistan. This work is arranged and present in different parts for easy approach. This is first ever attempt made to create seaweed flora along with establishment of seaweed herbarium, in the Department of Botany, University of Karachi.

This is the first part of seaweed flora with classification, description along with figures which have been studied during the last few decades. A number of collections and identification of seaweeds was carried out continuously with distinct emphasize on pure taxonomical way but restrict and confined to last two decades. Study of seaweeds was carried out by many researchers from Pakistan by focusing several different parameters. The ecological distributions and criteria of algae was initiated in that region by (Salim 1964) afterwards performed by (Begum and Khatoon 1988, Nizamuddin and Perveen 1986, Nizam and Saifullah 1967) while the biodiversity study of seaweeds was carried out by (Shameel and Afaq 1987, Shameel et al 1989). On the other hand, the denoted estimation of standing crop and biomass of seaweeds and was also carried out (Shaista and Muzammil 1999.

Systematics of Brown Seaweed:

PHYLUM:
PHAEOPHYCOTA SHAMEEL 2008
CLASS:
DICTYOPHYCEAE SHAMEEL 2001
ORDER:
ECTOCARPALES SETCHELL *ET* GARDNER 1922
Family:
Ectocarpaceae (Kützing) Harvey 1849
Genus:
Ectocarpus Lyngbye 1819
Ectocarpus columellaris Børgesen 1936
Ectocarpus elachistaeformis Heydrich 1892
Ectocarpus enhali Børgesen 1937
Ectocarpus filifer Børgesen 1937
Genus:
Feldmannia Hamel 1939
Feldmannia Hamel 1939
Feldmannia duchassaingiana (Grunow) Aisha *et* Shameel, *comb.nov.*
Feldmannia indica (Sonder) Womersely et Baily 1970
Feldmannia irregularis (Kützing) Hamel 1939
Feldmannia nizamuddinii Aisha et Shameel sp. nov.
Genus:
Hincksia Gray 1964
Hincksia conifera (Børgesen) Aisha et Shameel, comb.nov.
Hincksia mitchelliae (Harvey) Silva 1987
Hincksia nizamuddinii Aisha et Shameel, sp. nov.
Genus:
Spongonema Kützing 1849
Spongonema tomentosum (Hudson) Kützing 1849
Genus:
Streblonema Derbès et Solier 1851
Streblonema fasciculatum Thuret in Le Jolis 1863
Family:
Pilayellaceae Pedersen 1984
Genus:
Bachelotia (Bornet) Kuckuck ex Hamel 1939
Bachelotia antillarum (Grunow) Gerloff 1959
ORDER:
SPACELARALES OLTMANNS orth. mut. SHAMEEL 2008
Family:
Sphacelariaceae Decaisne 1842
Genus:
Sphacelaria Lyngbye 1818

Sphacelaria brachygona Montagne 1843
Sphacelaria hashmatii Aisha et Shameel, sp. Nov
Sphacelaria obaidii Aisha et Shameel, sp. nov
Sphacelaria nizamuddinii Aisha et Shameel, sp. nov
Sphacelaria rigidula Kützing 1843
Sphacelaria tribuloides Meneghini 1840

ORDER:
DICTYOTALES KJELLMAN 1893

Family:
Dictyotaceae (Lamouroux) Dumontier 1829

Genus:
Dictyopteris Lamouroux 1809
Dictyopetris australis (Sonder) Askenasy 1888
Dictyopetris delicatula Lamouroux 1809
Dictyopetris divaricata (Okamura) Okamura 1932
Dictyopetris nigricans Womersley 1949
Dictyopetris polypodioides (De Candolle) Lamouroux1809
Dictyopetris repens (Lamouroux) Børgesen 1924.
Dictyopetris tripolitana Nizamuddin 1981

Genus:
Dictyota Lamouroux 1809
Dictyota alternifida J. Agardh 1894
Dictyota bartayresiana Lamouroux 1809
Dictyota cervicornis Kützing 1859
Dictyota ciliata J. Agardh 1841
Dictyota dichotoma (Hudson) Lamouroux 1809
Dictyota dichotoma var. intricata (C. Agardh) Greville 1830
Dictyota divaricata Lamouroux 1809
Dictyota hauckiana Nizamuddin 1975
Dictyota maxima Zanardini 1872

Genus:
Lobophra J. Agardh 1894
Lobophora prostrata Aisha *et* Shameel, *sp. nov.*
Lobophora variegata (Lamouroux) Womersely 1967

Genus:
Padina Adanson 1763
Padina afaqhusainii Aisha *et* Shameel, *sp. nov.*
Padina fraseri (Greville) Greville 1930
Padina nizamuddinii Aisha *et* Shameel, *sp. nov.*
Padina pavonica (Linnaeus) Thivy *in* Taylor 1960
Padina tetrastrmatica Hauck 1887
Padina vickersiae Hoyt *in* Howe 1920

Genus:
Spatoglossum Kützing 1843
Spatoglossum asperum J. Agardh 1894

Spatoglossum schroederi (C. Agardh) Kützing 1894
Spatoglossum variabile Fiageri *et* De Notaris 1853

Genus:
Stoechospermum Kützing 1843.
Stoechospermum marginatum (C. Agardh) Kützing 1843

Genus:
Stypopodium Kützing 1843
Stypopodium shameelii Nizamuddin *et* Aisha1996
Stypopodium zonale (Lamouroux) Papenfuss 1940

CLASS:
LAMINAROPHYCEAE SHAMEEL 2008

ORDER:
CHORDARALES SETCHELL *et* GARDNER *orth. mut.* SHAMEEL 2008

Family:
Chordariaceae (C. Agardh) Greville 1830

Genus:
Levringia Kylin 1940
Levringia boergesenii Kylin 1940

Family:
Spermatochnaceae Kjellman 1890

Genus:
Nemacystus Derbès *et* Solièr 1850.
Nemacystus decipiens (Suringar) Kuckuck 1929

ORDER:
SCYTOSIPHONALES FELDMANN 1949

Family:
Scytosiphonaceae (Thuret) Hauck 1883

Genus:
Colpomenia (Endlicher) Derbès *et* Solier 1851
Colpomenia ecuticulata Parsons 1982.
Colpomenia hasanainii Aisha *et* Shameel, *sp. nov*
Colpomenia peregrine Sauvageau 1927
Colpomenia sinuosa (Mertens *ex* Roth) Derbès *et* Solièr 1851.

Genus:
Iyengaria Børgesen 1939
Iyengaria lobocylindrica Aisha *et* Shameel, *sp. nov*
Iyengaria stellata (Børgesen) Børgesen 1939

Genus:
Rosevingea Børgesen 1914
Rosenvingea intricata (J. Agardh) Børgesen 1914
Rosenvingea orientalis (J. Agardh) Børgesen 1914
Rosenvingea sanctae-crucis Børgesen 1914

Genus:
Jolyna Guimarães 1986
Jolyna laminarioides Guimarães in Guimarães et al.1986

CLASS:
FUCOPHYCEAE SHAMEEL 2008

Family:
Sargassaceae Kützing 1843

Genus:
Sargassum C. Agardh 1820:1
Sargassum acutifolium Greville 1840:256
S. carpophyllum J. Agardh 1889:82
S. divaraicatum Greville 1849:98
S. echinocarpum Greville
S. illicifolium (Turner) C. Agardh 1889: 94
S. obovatum J.Agardh 1889: 89
S. tenerrimum J.Agardh 1848: 305
S. wightii (Grev) J. Agardh 1889: 329

Genus:
Nizamuddinia Schiffner I934:118
Nizamuddinia zanardinii (Schiffner) Silva *in* Silva *et al.*1996: 655

Flora of Brown Seaweed:
Phylum:
Phaeophycota Shameel 2008:229
[=Phaeophyta Pascher 1914]

Key to Classes

1. Alternation between two generations----------2
   No alternation, only one generation present----------**Fucophyceae**
2. Alternation of morphologically similar generations----------**Dictyophyceae**
   Alternation of morphologically different generations----------**Laminarophyceae**

Class:
Dictyophyceae Shameel 2001:243
[= Isogeneratae Kylin 1933]

Key to Order

1. Thalli filamentous----------2
   Thalli parenchymatous----------**Dictyotales**
2. Filaments uniseriate; intercalary growth ----------**Ectocarpales**
   Filaments multiseriate; apical growth ----------**Sphacelarales**

Order:
Ectocarpales Setchell *et* Gardner 1922

Thalli mostly epilithic or epiphytic, occasionally endophytic; loose to dense tufts of uniseriate filaments, few to sometimes many cm high, heterotrichous; lower part

rhizoidal or pseudoparenchymatous, erect part sparsely branched, branches opposite, alternate or irregular; phaeoplasts discoid, band-shaped or stellate, few pyrenoids, grow mostly with intercalary meristem; reproduction by unilocular and plurilocular sporangia. This order includes two families which are distinguishable as follows:

Key to family

1. Thallus throughout filamentous; sporangia produced as special organ…… …… ……**Ectocarpaceae**
   Thallus basally parenchymatous; sporangia arise by simple vegetative cells----------
   ----------**Pilayellaceae**

Family:
Ectocarpaceae (Kützing 1843) Harvey 1849

Thalli are morphologically similar and have same mode of reproduction. The epilithic members of the family have heterotrichous habit, which means lower creeping part with erect branched system. Epiphytic thallus penetrates into host, occasionally pseudoparenchymatous endophytic lower portion and upper erect part. Thallus with much branched main axis, filaments composed of uniseriate series of rectangular to quadrate cells; phaeoplasts discoid, elongated or band-shaped, rarely stellate; plurilocular sporangia cylindrical, elongate, oblong and conical in shape, sessile as well as pedicellate; growth zones found on main axis as well as on lateral branches. It is represented at the coast of Karachi by five genera, which may be distinguished as follows.

Key to genra

1. Phaeoplasts oblong or band-shaped ----------2
   Phaeoplasts discoid or stellate ----------3
2. Thalli mainly endophytic ----------***Streblonema***
   Thalli epiphytic or epilithic, sometimes basally endophytic ----------4
3. Filaments with curved tips----------***Spongonema***
   Filaments without curved tips ----------***Ectocarpus***
4. Meristematic zones only on main axis with sessile reproductive bodies -----***Hincksia***
   Meristematic zones on main axis as well as on lateral branches with
   pedicellate reproductive bodies ----------***Feldmannia***

Genus:
***Ectocarpus* Lyngbye 1819**

Thalli filamentous, epiphytic, sometimes endophytic; heterotrichous, lower part mostly rhizoidal, rarely pseudoparenchymatous, upper part much branched; filaments nearly equal in breadth from base to apex; branches mostly with obtuse tips, sometimes terminal cell of the branches converted into plurilocular sporangia; filaments composed of rectangular or quadrate cells; phaeoplasts band-shaped or elongated pieces, with few pyrenoids; phaeophycotian hairs absent; growth by intercalary meristem, only found on main axis; plurilocular sporangia cylindrical or oblong in shape, sessile or pedicellate. It

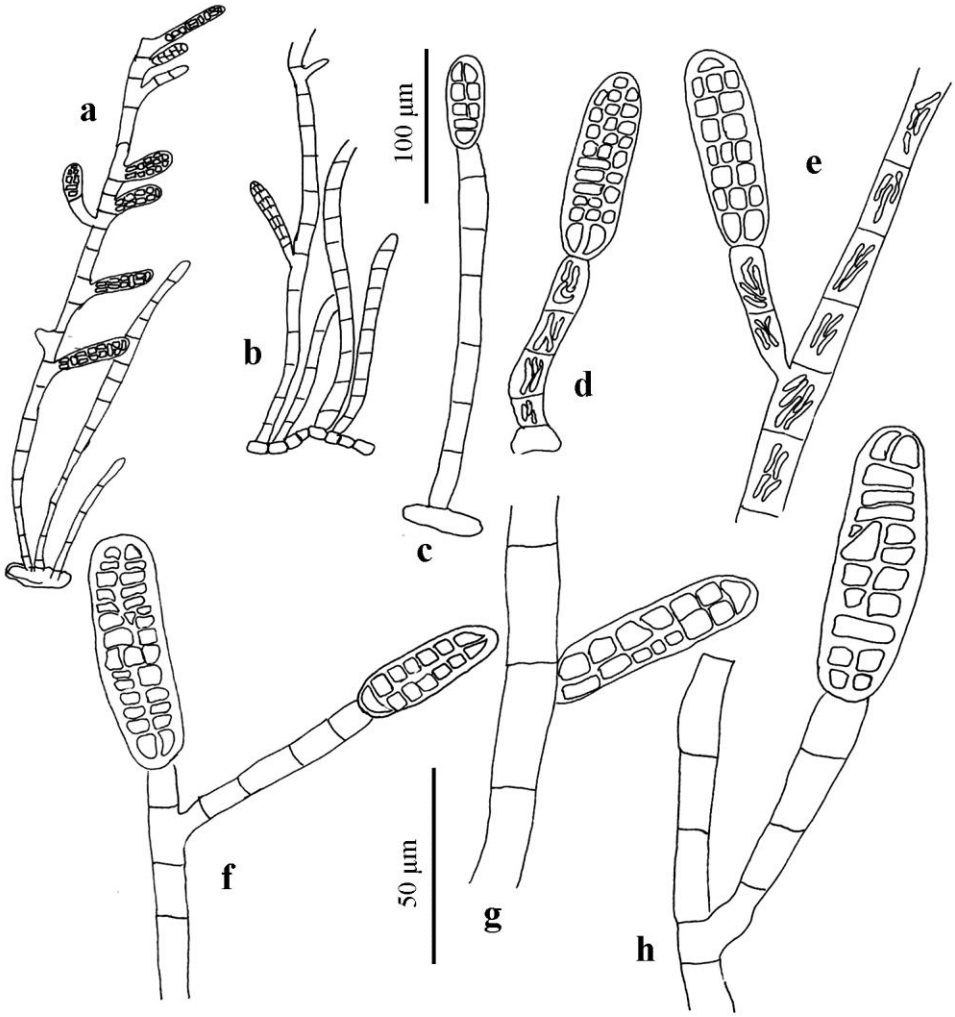

Fig. 4. *Ectocarpus columellaris* Børgesen: a, Filaments arising from substratum; b, Erect filaments arising from creeping rhizoidal filament; c, Filament bearing long, terminal, biseriate plurilocular sporangium; d, Filament bearing terminal, multiseriate plurilocular sporangium; e & f, Filaments with lateral, pedicellate plurilocular sporangia; g, Filament with lateral, and terminal pedicellate plurilocular sporangia; h, Filament with lateral, sessile plurilocular sporangium.

is represented by four species at the coast of Karachi, they are distinguished as described below.

Key to Species

1. Thalli basally endophytic ----------2

   Thalli epiphytic ----------3

2. Lower creeping portion rhizoidal----------***E. enhali***

   Lower creeping portion parenchymatous----------***E. filifer***

3. Plurilocular sporangia cylindrical, ----------***E. columellaris***

   Plurilocular sporangia oblong to elongated, ----------***E. elachistaeformis***

***Ectocarpus columellaris* Børgesen 1936: 71** (Fig. 4 a-h)

Synonyms: *Feldmannia columellaris* (Børgesen) Islam 1976:32; *Hecatonema columellare* Balakrishnan *et* Kinkar 1981:23.

References: Børgesen, 1936:71; Misra, 1966:83; Krishnamurthy and Joshi, 1970: 9; Islam, 1976:32; Balakrishnan and Kinkar, 1981:23; Silva *et al.*, 1987: 73; 1996:562.

Thalli few mm high, epiphytic on *Cystoseira indica* (Thivy *et* Doshi) Mairh, *Padina* spp. and *Spatoglossum* spp. forming loose to dense dark brown tufts.Filaments forming tufts; basally attached to host by creeping rhizoidal filaments; it makes heterothallic nature of the thallus, 213-662 µm long; composed of rectangular cells, 19-28 µm in length, 6-9 µm in breath; band-shaped or elongated pieces of phaeoplast found in the centre of each cell of the filaments, sometimes attached towards terminal part; each filament with round apex; branches very few and short.Plurilocular sporangia frequently found on main as well as on lateral branches, cylindrical in shape, with blunt tips, 40-59 µm long, 12-19 µm wide, sessile as well as pedicellate; pedicel 2-4 celled, (9-) 12-22 (-31) µm in length, 6-12 µm in breath; unilocular sporangia were not observed in these specimens. Growth zones were not observed either on main filaments or on lateral branches. It was found growing as epiphyte on other brown algae like C*ystoseira indica* (Thivy *et* Doshi) Mairh, *Padina* spp. and *Spatoglossum* spp. in association with some red algae like *Acrochaetium* spp. and *Bangia atropurpurea*.

Type locality: Galle, Sri Lanka.Roth) C. Agardh.

Local distribution: Buleji (*Leg.* Aisha 2-10-1989), Manora (*Leg.* Aisha 11-11-1989, 21-12-1992).

Geographical distribution: Bangladesh, India, Iraq, The Philippines and Sri Lanka.

***Ectocarpus elachistaeformis* Heydrich 1892: 470** (Fig. 5 a-f)

Synonyms: *Feldmannia elachistaeformis* (Heydrich) Pham-Hoàng Hô 1969:299, *Kuetingiella elachistaeformis* (Heydrich) Balakrishnan *et* Kinkar 1981: 25.

References: Børgesen, 1914 :174; Taylor, 1928:107; Misra, 1966:77; Earle, 1969:133; Pham-Hoàng Hô, 1969: 299; Krishnamurthy and Joshi, 1970: 9; Islam, 1976: 32; Balakrishnan and Kinkar, 1981: 25; Silva *et al.*,1996: 570.

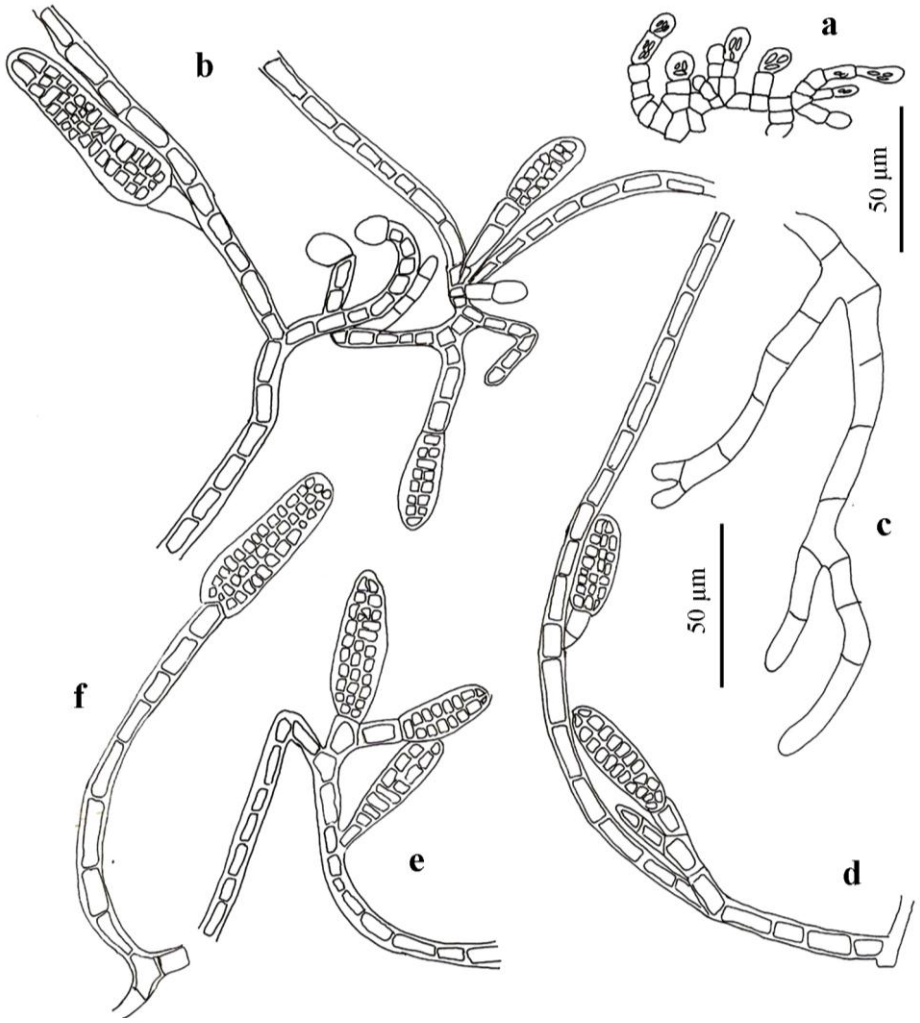

Fig. 5. *Ectocarpus elachistaeformis* Heydrich: a, Filaments showing epiphytic parts; b, Habit of the thallus (enlarged); c, Rhizoidal filaments; d, Filament bearing pedicellate, biseriate and multiseriate plurilocular sporangia; e, Single pedicel cell bearing two plurilocular sporangia; f, Filament with terminal plurilocular sporangium.

Thalli epiphytic on *Codium* spp., forming light brown patches on the host. Thalli filamentous, 136-512 µm in length, lower epiphytic part with creeping filaments; basal part of thallus with lesser length of cells and apical cell globular in shape, 9-22 µm (-25 µm) in length, 6-9 µm (-12 µm) in breath; in upper part filaments consist of rectangular cells; cells longer as compared to width, 15-19 µm long and 3-9 µm broad; phaeoplasts small and elongated pieces, filling the cavity of cells; branches absent, if present then in

terminal part with plurilocular sporangia; attached to host by creeping lower part or rhizoidal filaments, with few phaeoplasts. The specimens had only plurilocular sporangia, unilocular sporangia were absent; plurilocular sporangia mostly terminal in position, but lateral sporangia were also observed; lateral sporangia with 1-3 celled stalk, 12-22 µm long, 9-12 µm broad; terminal sporangia oblong to elongated in shape, tapering towards apex, 31-68 µm in length, 12-15 µm in breath, occasionally a single stalk developed two plurilocular sporangia. The lower or broad part of the filaments with small meristematic zones of 2-3 cells, indicating intercalary growth.: It was found as epiphyte on *Codium* spp.

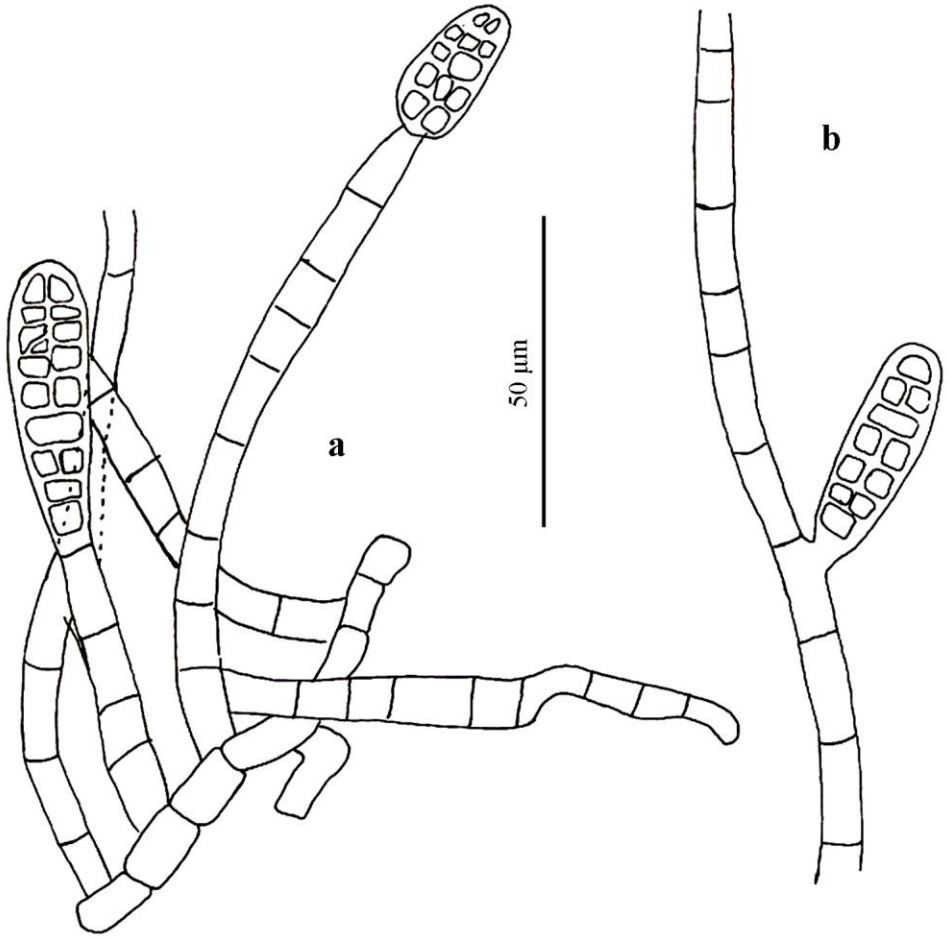

Fig. 6. *Ectocarpus enhali* Børgesen: a, Habit of the thallus; b, Filament with lateral, sessile, biseriate plurilocular sporangium.

Type locality: Hatzfeldthaven, Papua New Guinea.
Local distribution: Manora (*Leg.* Nizamuddin 12-12-1989).

Geographical distribution: West Indies, Florida, Mexico, Bermuda, Western Atlantic, Red Sea, Gulf of Aden: Bangladesh, India, Mauritius and Scychelles (Mahi Island).

***Ectocarpus enhali* Børgesen 1937: 8** (Fig. 6 a, b)

Synonyms: *Hecatonema enhali* (Børgesen) Balakrishnan *et* Kinkar 1981:22.

References: Børgesen, 1937:8; Misra, 1966:82; Balakrishnan and Kinkar, 1981:22; Silva *et al.*,1996: 622.

Thallus forming dark brown patches on *Padina* spp., basally endophytic. Filaments forming heterotrichous dense tufts; lower creeping portion of filament endophytic, with transversely arranged rectangular cells, 15-25 (-31) µm long, 9 µm in diameter; from creeping portion erect filament arises, each filament with uniseriate series of rectangular cells (15-) 19-31 µm in length, 6-12 µm in breadth; in the centre of cell elongated pieces or band-shaped phaeoplasts; branches absent, filaments terminally end into rounded tips. Unilocular sporangia were not recorded in these specimens; plurilocular sporangia quite frequent, mostly terminal and also lateral in position, sessile, rarely with a single celled stalk, cylindrical in shape with round apex, 30-46 µm in length, 12-15 µm in breadth. Thallus lack a meristematic zone of growth, cells of basal portion give upper erect filaments. Sometimes a single basal cell gives more than 2-3 filaments. Thallus occurring as brown tufts on *Padina* spp. which were growing in shallow pools of water in the upper littoral zone. as brown tufts on *Padina* spp. which were growing in shallow pools of water in the upper littoral zone.

Type locality: Pamban, Tamil Nadu, India.

Local distribution: Buleji (*Leg.* Aisha 2-10-1989).

Geographical distribution: India.

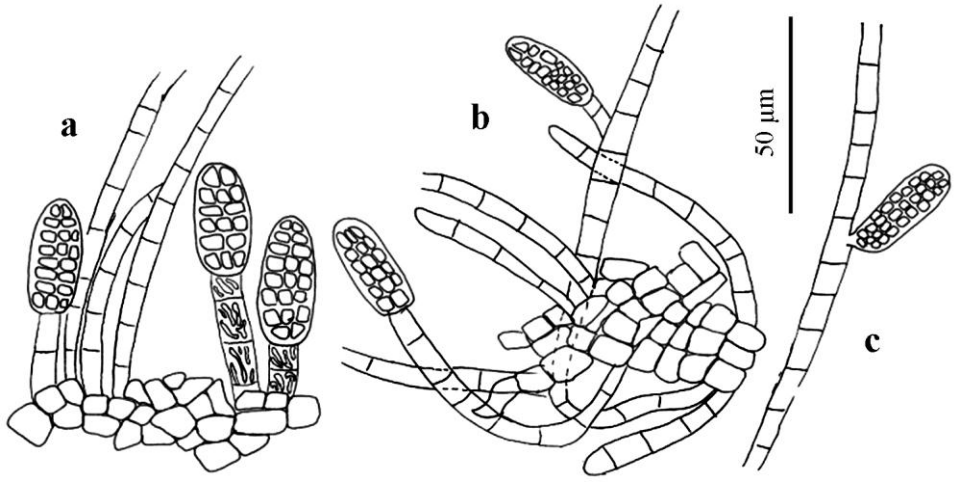

Fig. 7. *Ectocarpus filifer* Børgesen: a, Habit of the thallus with terminal, plurilocular sporangia; b, Habit of the thallus with terminal and lateral, plurilocular sporangia; c, Filament bearing sessile, lateral, multiseriate plurilocular sporangium.

***Ectocarpus filifer* Børgesen 1937: 10** (Fig. 7 a-c)

Synonym: *Feldmannia filifera* (Børgesen) Pham-Hoàng Hô 1969 :301.

References: Børgesen, 1937 :10; Misra, 1966 :80; Pham-Hoàng Hô, 1969 :301; Silva *et al.,* 1996: 563.

Thallus forming reddish brown patches on *Spatoglossµm variabile* Figari *et* De Notaris. It is basally endophytic. Thallus endophytic, basal creeping part pseudo-parenchymatous; erect filaments arise from endophytic part; each filament consists of uniseriate series of rectangular cells, (15-) 22-25 (-28) µm in length, 6-9 µm in breadth; phaeoplasts band-shaped, centrally located; filaments mostly unbranched, rarely branched, have more or less same diameter throughout; end cells with round tips. Unilocular sporangia were not observed in these specimens; plurilocular sporangia common, elongated in shape with rounded apex, (37-) 43-56 (-62) µm long, (6-) 12-15 µm broad, terminal as well as lateral in position; pedicel of 1-3 cells, 15-22 µm high, 9-12 µm wide. Thallus lacks a growth zone. It was found endophytically inside *Spatoglossµm variabile* Figari *et* De Notaris, which was growing on sheltered rocks at Buleji and Nathiagali.

Type locality: Mahabalipurum, near Chennai, India.

Local distribution: Buleji (*Leg.* Aisha 2-10-1989), Nathiagali (*Leg.* Aisha 11-11- & 14-11-1989).

Geographical distribution: India and Vietnam.

Genus *Feldmannia* G. Hamel 1939

Thalli filamentous, heterotrichous, epiphytic, endophytic or epilithic; sparsely branched, alternate to opposite, branches acute; uniseriate filaments containing barrel-shaped or quadrate cells; phaeoplasts many, discoid, with few pyrenoids; growth by intercalary meristem, found on main axis as well as on lateral branches; plurilocular sporangia conical, cylindrical in shape, mostly pedicellate rarely sessile. Its four species have been collected, which are distinguishable as given below:

Key to Species

1. Filaments endophytic----------*F. nizamuddinii*
   Filaments epiphytic or epilithic ----------2
2. Plurilocular sporangia cylindrical----------*F. duchassaingiana*
   Plurilocular sporangia not cylindrical----------3
3. Fruiting bodies found below the meristematic zone----------*F. indica*
   Fruiting bodies otherwise ----------*F. irregularis*

Feldmannia duchassaingiana* (Grunow) Aisha *et* Shameel, *comb. nov. (Fig.8 a-g)

Basionym: *Ectocarpus duchassaingianus* Grunow 1867:45.

Synonym: *Giffordia duchassaingiana* (Grunow) W. R.Taylor 1960:207.

References: Børgesen, 1914:15; Taylor, 1928:107; 1960:207, Misra, 1966:93; Islam, 1976:30; Silva *et ai.,* 1996:563.

Thallus up to 3 cm high; attached by very minute disc-shaped holdfast; brown to olive green in colour; sparsely branched; appears like a woolen thread.

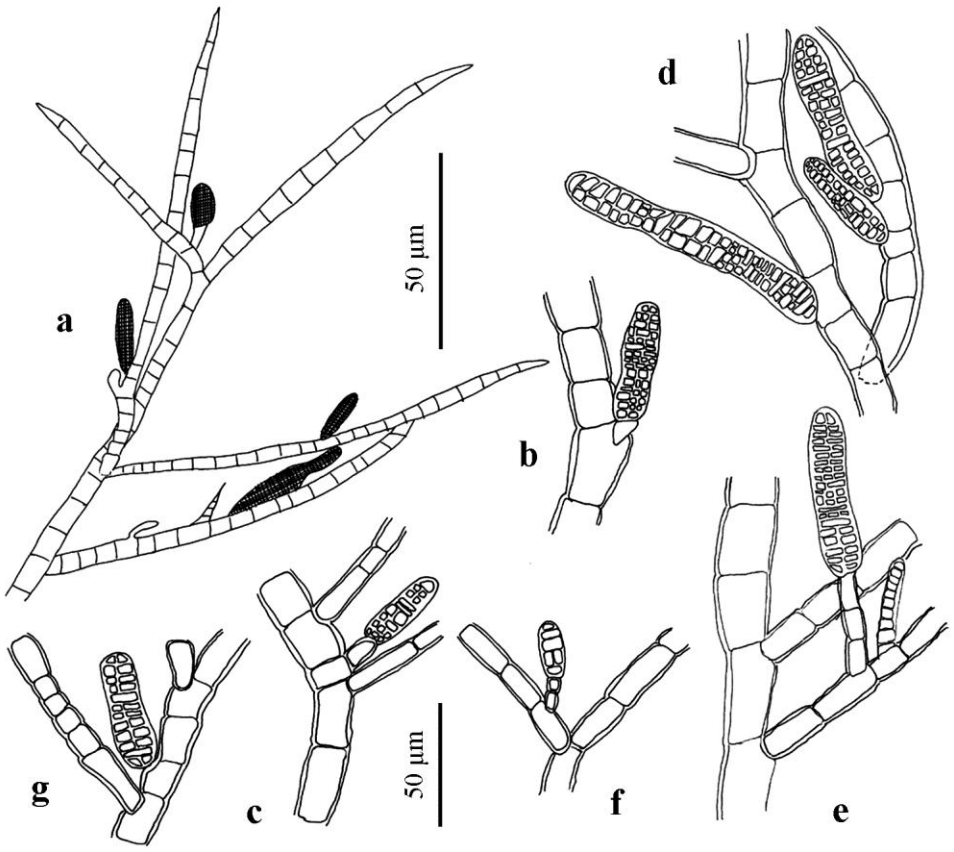

Fig. 8. *Feldmannia duchassaingiana* (Grunow) Aisha et Shameel: a, Habit of the thallus; b & c, Filaments with lateral plurilocular sporangia having triangular to rectangular pedicel cell; d & e, Filaments bearing lateral and sessile as well as terminal, pedicellate, multiseriate plurilocular sporangia; f & g, Lateral branches and pedicellate plurilocular sporangia.

Thallus filamentous; consists of series of rectangular cells, (28-) 46-83 µm in length, 30-40 (-43) µm in breadth at main filaments; branches irregular, terminally taper with obtuse tips, 22-83 µm long, (9-) 12-25 µm broad; each cell with many discoid phaeoplasts, almost filling the lumen of the cell. Unilocular sporangia not observed; plurilocular sporangia cylindrical with blunt apices, frequently found on main axis as well as on lateral branches or ramuli, mostly sessile but sometime pedicellate, 1-4 celled, 12-22 µm long, 12-15 µm wide; sporangia show delayed division in some, but most locules have regular divisions. Meristematic region found on main axis as well as lateral branches, which means growth is intercalary. Thalli growing epilithic on muddy rocks of shallow pools and channels.

Type locality: Guadeloupe, West Indies.

Local distribution: Hawkesbay (*Leg.* Aisha 16-10- & 14-11-1989).

Geographical distribution: Bangladesh, Diego Garcia Atoll, India, Iraq, Kenya, Tanzania, West Indies, USA and Pakistan.

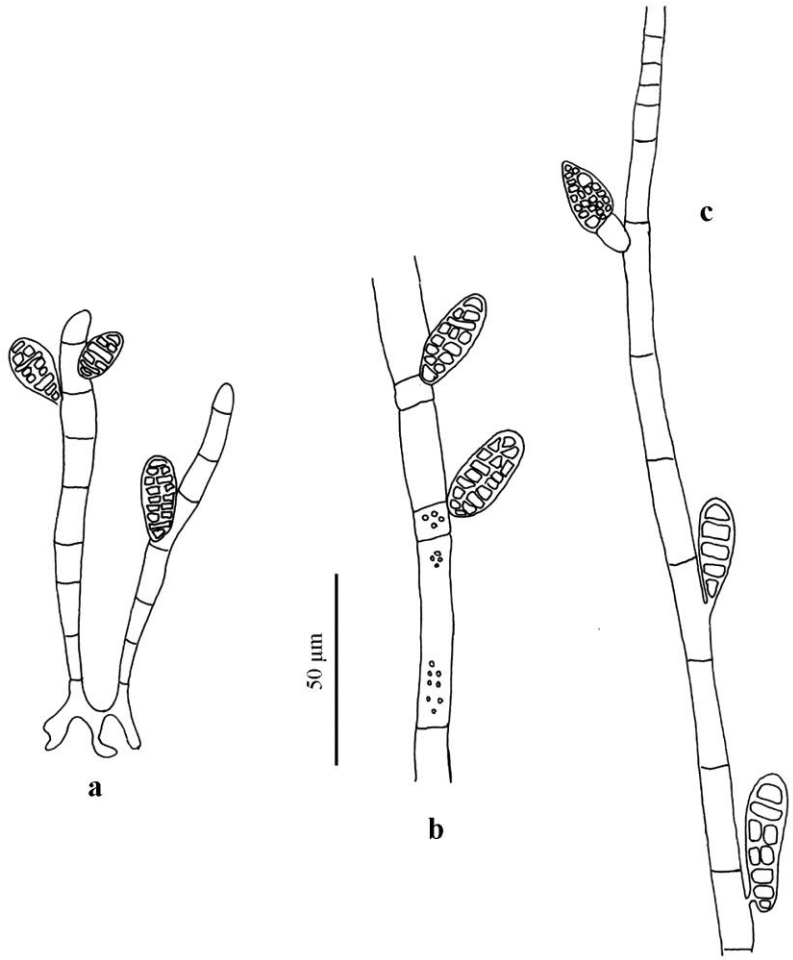

Fig. 9. *Feldmannia indica* (Sonder) Womersley *et* Baily: a, Habit of the thallus; b, Filament with lateral, sessile plurilocular sporangia arising from small cells; c, Filament bearing lateral, sessile as well as pedicellate, multiseriate plurilocular sporangia.

***Feldmannia indica* (Sonder) Womersley *et* Bailey 1970: 288** (Fig. 9 a-c)

Basionym: *Ectocarpus indicus* Sonder 1854:2.
Synonym: *Giffordia indica* (Sonder) Papenfuss *et* Chichara *in* Papenfuss 1968 :30.

References: Børgesen, 1914:3, 1941:16; Dawson, 1956:43; Earle, 1969:136; Womersley & Bailey, 1970:299; Islam, 1976:33; Jaasund, 1976:35; Balakrishnan & Kinkar, 1981:18; Silva *et al.*, 1987:73, 1996:563.

Thalli epiphytic on *Dictyopteris membrancea* (Stackhouse) Batters which were found in drift form, forming dark brown patches on the host. Thallus filamentous; rare, irregularly branched, obtuse tips; phaeoplasts many, discoid, distributed all over in the cell content; cells square, rectangular to elongated, cells uniseriately arranged, 57-125(-136) µm in length, 34-47 µm in breadth. It reproduced by plurilocular sporangia, oval in shape, terminal as well as laterally located; biseriate locules 68 -125 µm long, 45- 68 µm broad; mostly sessile but rarely single basal cells present; 45 µm high, 34 µm wide. The growth takes place by intercalary meristem, which is mostly located at upper part of the filament below plurilocular sporangia. Thalli found epiphytic on *Dictyopteris membrancea* (Stackhouse) Batters, which occurs in drift form.

Type locality: Bima Bay, Sumbawa, Indonesia.

Local distribution: Buleji (*Leg.* Aisha 29-12-1990).

Geographical distribution: Chagos Archipelago, Diego Garcia, India, Indonesia, Iraq, Kenya, Kuwait, Maldives, Mauritius, Réunion, Singapore, Somalia, Sri Lanka and Tanzania.

***Feldmannia irregularis* (Kützing) G. Hamel 1939: 17** (Fig. 10 a- d)

Basionym: *Ectocarpus irregularis* Kützing 1845: 234.

Synonym: *Giffordia irregularis* (Kützing) Joly 1965: 72.

References: Børgesen, 1914: 23; Hamel, 1931: 45; Lindauer *et al.*, 1961: 48; Misra, 1966 :78; Krishnamurthy & Joshi, 1970:10; Abbott & Hollenberg, 1976:136; Islam, 1976:30; Silva *et al.*, 1987: 73, 1996: 564; Womersley, 1987: 42; Shameel *et al.*, 1996: 226, 2000: 83.

Thallus 2-3 mm high, appears like a cluster of woolen threads of light brown colour which later become olive green; attached with the help of a discoid holdfast. Thallus filamentous; composed of uniseriate rows of cells; cells of main filament 22-56 µm in length, 19-40 µm in breadth; sparsely branched, branches somewhat irregular, alternate to opposite; terminal part tapers with obtuse tip; each branch ends into false hair-like structure, 19-46 µm long, 15-22 µm broad; apical cell of branches and filaments flat at one side, but other side blunt, 9-28 µm high, 6-9 (-15) µm wide; pyrenoids rare. Reproduction takes place by unilocular and plurilocular sporangia; plurilocular sporangia, conical in shape, lateral and axillary in position, mostly single, sometimes in a group of 2-3, 46- 83 µm in length, (19-) 22-28 µm in breadth, mostly sessile, rarely pedicellate. The growth in this species is mainly intercalary, meristematic zones on the main axis are quite prominent as well as on the branches. t was growing epilithic on the rocks of shallow pools and also in the channels on the coast as well as epiphytic on *Dictyota* spp. It was found in association with *Hincksia mitchelliae* (Harvey) Silva.

Type locality: Adriatic Sea.

Local distribution: Manora (*Leg.* Nizamuddin 24-1-1962); Hawkesbay (*Leg.* Aisha 14-11-1989, 16-10-1990).

Geographical distribution: Australia, Bangladesh, Brazil, California, Canary Island, Europe, India, Kuwait, Maldives, Mauritius, Mozambique, New Zealand, Pakistan, Saudi Arabia, Somalia, Sri Lanka, Tanzania, United Kingdom, West Indies and Yemen.

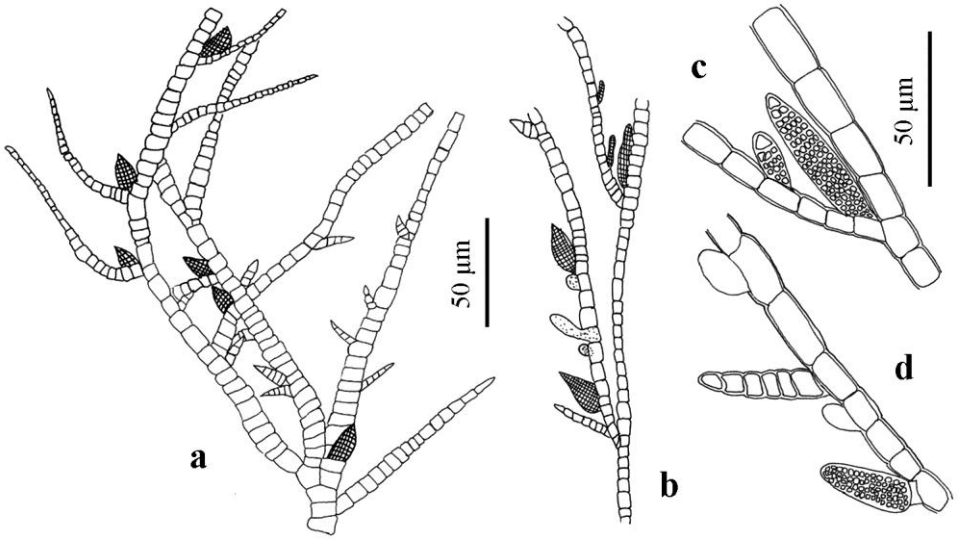

Fig. 10. *Feldmannia irregularis* (Kützing) Hamel: a & b, Habit of the thallus; c, Lateral branch bearing sessile plurilocular sporangia; d, Filament bearing lateral, pedicellate, multiseriate plurilocular sporangium and sessile unilocular sporangia.

***Feldmannia nizamuddinii* Aisha *et* Shameel, *sp. nov*.** (Fig. 11 a-h)

Diagnosis: *Fila endophytica, solus basaliter ramosus, phaeoplastis discoides, ne definitus zona crescentia, sporangia unilocularia ovaliformia et pedicellata, sporangia plurilocularia cylindriceae ad conicus, sessilis et pedicellatis.*

Thallus growing on *Codium* spp. forming tufts of light brown colour, 2 mm in diameter. Thallus endophytic; lower part consists of branched rhizoidal filaments, 28-37 (-53) µm long, 22-28 (-42) µm broad; upper filamentous part basally branched; each filament bears uniseriate rectangular or squarish cells, (15-) 19-28 (-46) µm in length, (12-) 15-19 µm in breadth, thickness of filaments throughout same; phaeoplasts many, discoid, almost filling the cavity of the cells. It reproduces by means of plurilocular and unilocular sporangia. Both sporangia arise from those cells of the filaments which are short in length and are usually placed in upper part of the filaments. Unilocular sporangia are sessile, oval in shape, 40-68 µm in length, 19-31 µm in breadth; plurilocular sporangia are of two types, one sessile and other with single pedicel cell, cylindrical to conical in shape, (43-) 59-108 (-133) µm high, 22-43 µm wide. Growth mainly takes

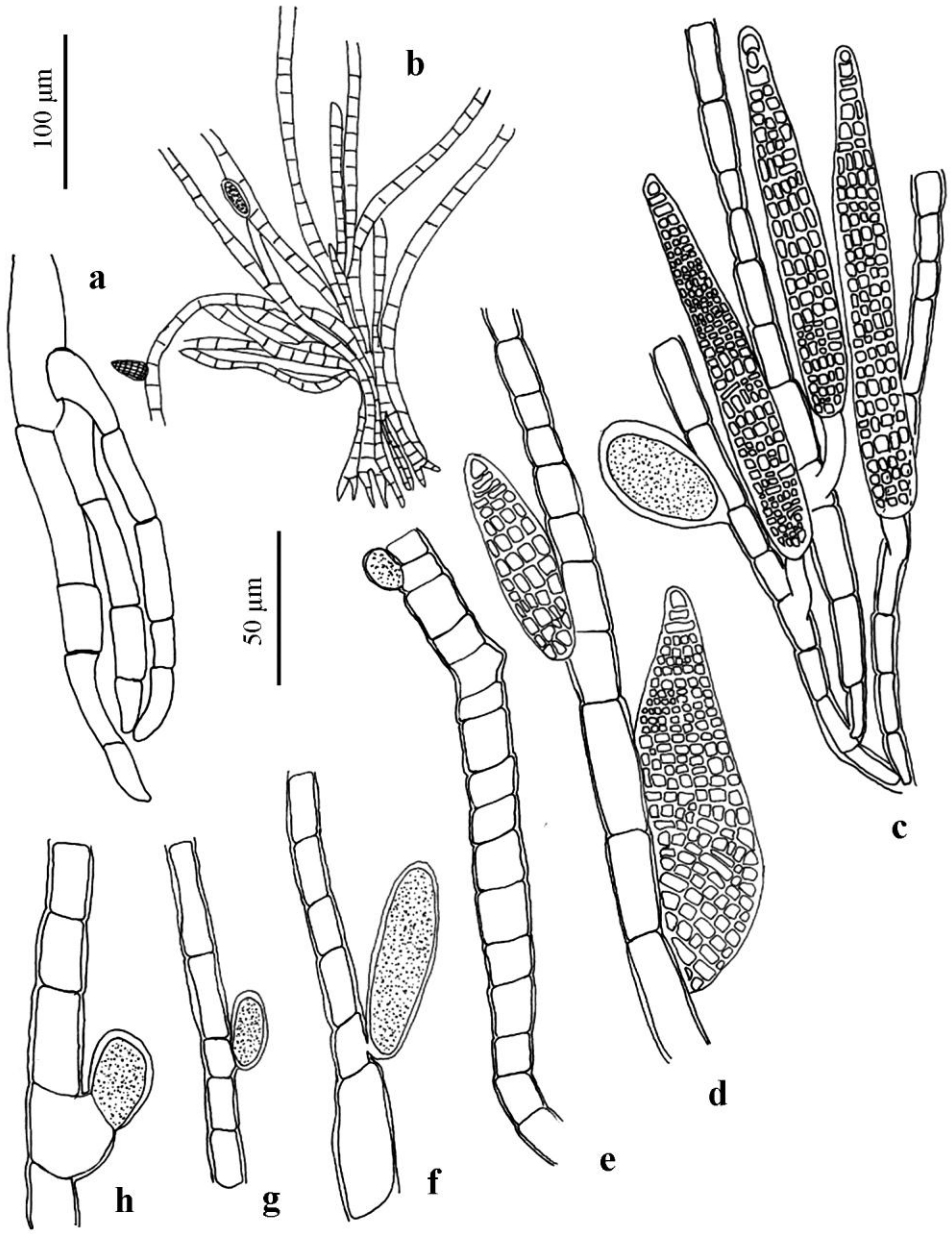

Fig. 11. *Feldmania nizamuddinii* Aisha et Shameel: a, Rhizoidal portion of the thallus; b, Habit of the thallus; c, Filaments bearing lateral, pedicellate, multiseriate plurilocular sporangia and a unilocular sporangium; d, Filament with elongated and conical, sessile multiseriate sporangia; e, f, g & h, Filaments showing development of unilocular sporangia.

place by intercalary meristems, which are not localized in a definite zone on the filaments. It was found growing endophytically on *Codium* spp., which were collected in drifted form.

Type locality: Cape Monze, Karachi, Pakistan (*Leg.* Afaq-Husain 1-2-1985).

Genus *Hincksia* J. Gray 1964

Thalli form dense tufts on rocks; epilithic, attached by small minute disc-shaped holdfast; branches unilateral, opposite and sparse, attenuated towards tips; forming false-hair like structure at the end of branches; uniseriate filaments consist of rectangular, square or barrel-shaped cells; cells with many discoid phaeoplasts. Its following three species have been collected which may be distinguished as given below:

Key to Species

1. Filaments dichotomously branched----------*H. nizamuddinii*
   Filaments with lateral branching ----------2
2. Branches mostly unilateral----------*H. mitchelliae*
   Branching pattern irregular ----------*H. conifera*

Hincksia conifera* (Børgesen) Aisha *et* Shameel, *comb. nov. (Fig. 12 a-e)

Basionym: *Ectocarpus conifer* Børgesen 1914:8 (*coniferus)*.

Synonym: *Giffordia conifera* (Børgesen) W. R. Taylor 1960:207.

References: Børgesen, 1914:8; Lindauer *et al.*, 1961:148; Misra, 1966:96; Earle, 1969:135; Krishnamurithy & Joshi, 1970:10; Islam, 1976:28; Jaasund, 1976:35; Silva *et al.*, 1996:564.

Thallus 4-5 cm high, attached on muddy rocks, forms light to dark brown clump, appears like woolen balls. Thallus filamentous, attached to substratum with the help of rhizoidal filaments with few phaeoplasts; filaments consist of uniseriate series of rectangular to squarish cells; cells 12-37 µm long, 22-31 µm broad, filled with dense discoid phaeoplasts; thallus irregularly branched, tapering towards the apex, branches at right angle to the main axis as well as close to the main axis forming acute angle; cells of branches also rectangular or squarish in shape, 15-34 µm in length, 22-25 µm in breadth. The reproduction takes place by plurilocular sporangia, which are cylindrical or oblong, with round basal part, sessile, never pedicellate, 40-93 µm in length, 22-31 µm in breadth, found on main axis as well as on lateral branches, sometimes found at lower part of lateral branches, but mostly placed in the corner between main filament and lateral branches. There appear 1-3 series of plurilocular sporangia on lateral branches, unilocular sporangia were not recorded in these specimens. The species is characterised by intercalary meristematic regions, which were found on main axis as well as on lateral branches. It was found growing epilithic on the flat rocks and shallow water pools in upper littoral zone.

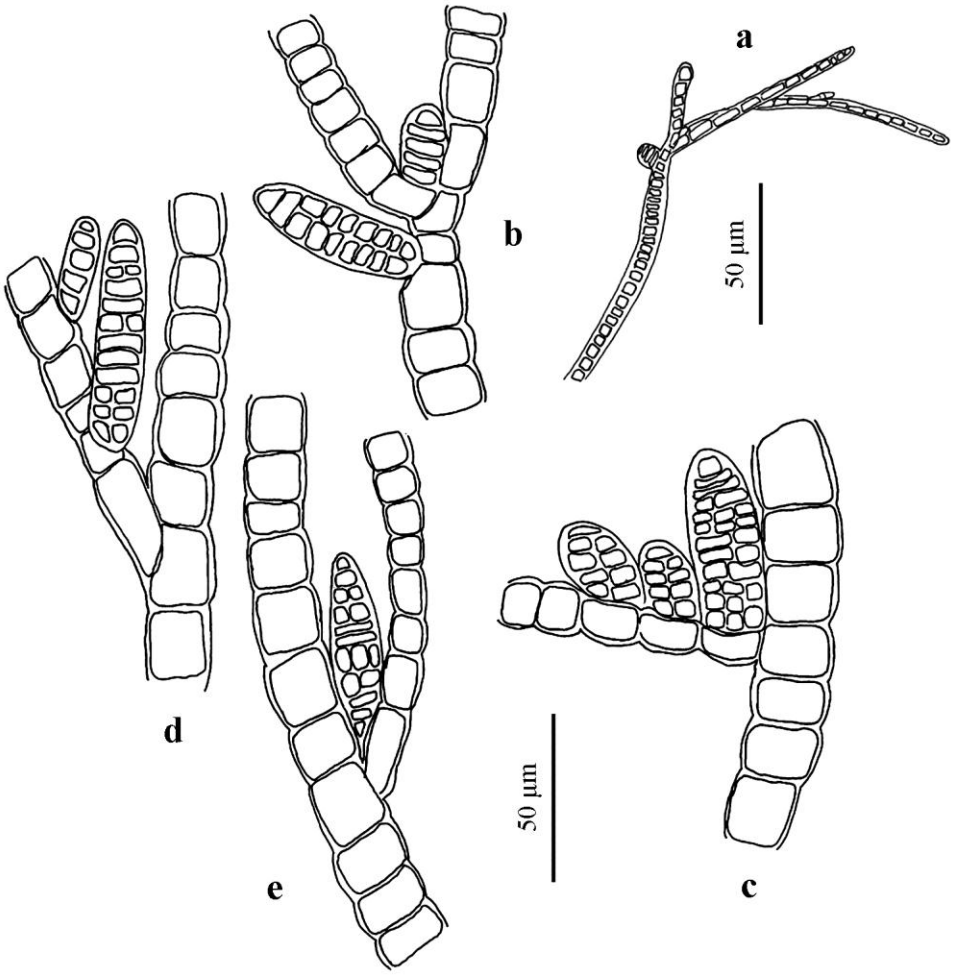

Fig. 12. *Hincksia conifera* (Børgesen) Aisha et Shameel: a, Vegetative filament of thallus; b, Filament with uniseriate and biseriate, sessile, lateral plurilocular sporangia; c & d, Lateral branches bearing lateral, sessile, multiseriate plurilocular sporangia; e, Sessile, axial, lateral plurilocular sporangia.

Type locality: St. Jan (St. John), Virgin Islands.

Local distribution: Sandspit (*Leg.* Aisha 27-10-1992); Hawkesbay (*Leg.* Aisha 14-11-1989).

Geographical distribution: Bangladesh, India, New Zealand, Tanzania, West Indies *etc*.

***Hincksia mitchelliae* (Harvey) P. Silva *in* Silva *et al.* 1987: 73** (Fig. 13 a-c)

Basionym: *Ectocarpus mitchelliae* Harvey 1852: 142.

Synonym: *Giffordia mitchelliae* (Harvey) Hamel 1939: 66.

References: Børgesen, 1914: 162, 1930: 165, 1937: 4, 1939: 75; Hamel, 1939: 29; Misra, 1966: 91; Earle, 1969: 138; Krishnamurithy & Joshi, 1970: 10; Nizamuddin & Gessner, 1970: 5; Abbott & Hollenberg, 1976: 143; Islam, 1976: 30; Jaasund, 1976: 35; Silva *et al.*, 1987: 73, 1996: 568; Shameel, 1987: 170, 2000: 51; Shameel & Afaq-Husain, 1987: 294; Womersley, 1987: 52; Begum & Khatoon, 1988: 292, 1992: 243; Shameel *et al.*, 1989: 178, 1996: 226, 2000: 83; Shameel & Tanaka, 1992: 35; Shaikh & Shameel, 1995: 11.

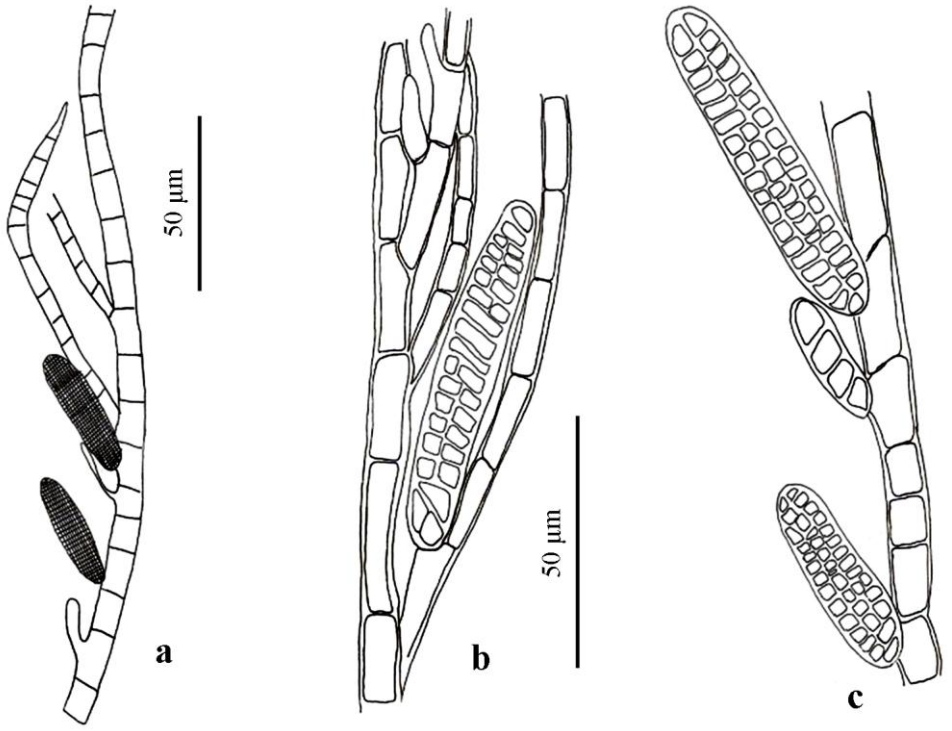

Fig. 13. *Hincksia mitchellae* (Harvey) Silva: a, Habit of thallus; b, Lateral branch bearing sessile, biseriate, lateral plurilocular sporangium; c, Filament with lateral, sessile, multiseriate plurilocular sporangia.

Thalli up to 5 mm high, attached with the help of small disc-shaped holdfast, appear as brown clusters of thread. Thallus filamentous; filaments consist of rectangular to barrel-shaped cells; cells 23-34 µm in length, 23-28 µm in breadth; branching well developed, lateral branches mostly unilateral; small lateral branches like ramuli, tapering upwards, 80-102 µm long; apical cells elongated, 22-46 µm long, 5-6 µm broad; numerous discoid phaeoplasts, with 2 or 3 pyrenoids, Unilocular sporangia not recorded; plurilocular sporangia frequent, cylindrical in shape, lateral in position, sessile throughout, developed on main axis as well as on lateral branches, 80-102 µm in length

and 23- 34 µm in breadth. Thallus has intercalary meristematic regions, which are on the main axis. They developed at upper and lower part of the main axis from where lateral branches arise. Thalli were found growing epilithic in shallow pools as well as in muddy water channels on rocky plateforms.

Type locality: Nantucket, Massachusetts, USA.

Local distribution: Manora (*Leg.* Nizamuddin 3-2-, 4-6- & 21-11-1964, *Leg*. Aisha 28-1-1991); Hawkesbay (*Leg.* Aisha 16-10- & 14-11-1989, 29-12-1990, *Leg.* Nizamuddin 25-4-1993); Paradise Point (*Leg.* Nizamuddin 12-12-1965); Cape Monze (*Leg.* Nizamuddin 30-12-1964); Miani Beach (*Leg.* Nizamuddin 24-12-1964).

Geographical distribution: Australia, Bangladesh, India, Iran, Iraq, Kenya, Kuwait, Mauritius, New Zealand, Pakistan, Réunion, Saudi Arabia, Seychelles, South Africa, Tanzania, U.K., U. S. A. and West Indies.

Hincksia nizamuddinii* Aisha *et* Shameel, *sp. nov. (Fig. 14 a-e)

Diagnosis: *Fila dicotome ramosa, phaeoplastis discoidis, meristimatica zona basi lateralis ramosis, sporangia plurilocularia ovalis ad oblongis et sessilis.*

Thalli up to 10 cm high, light brown in colour; attached on sandy and muddy rocks of Karachi coast, appear as clusters of woolen threads. Thallus filamentous, attached to substratum with the help of creeping, irregular rhizoidal filaments; main filaments composed of uniseriate series of rectangular cells; cells 49-71 (-102) µm long, 19-31 µm broad; thallus dichotomously branched, each branch tapers towards tip and forms hair-like apex; lateral branches also with rectangular cells except the cells from which branching takes place, 25-40 (-49) µm in length, 12-19 µm in breadth; phaeoplasts few, discoid, with 1-2 pyrenoids.

The reproduction mainly takes place by plurilocular sporangia, unilocular sporangia were not observed in these specimens; plurilocular sporangia were few in numbers, oval

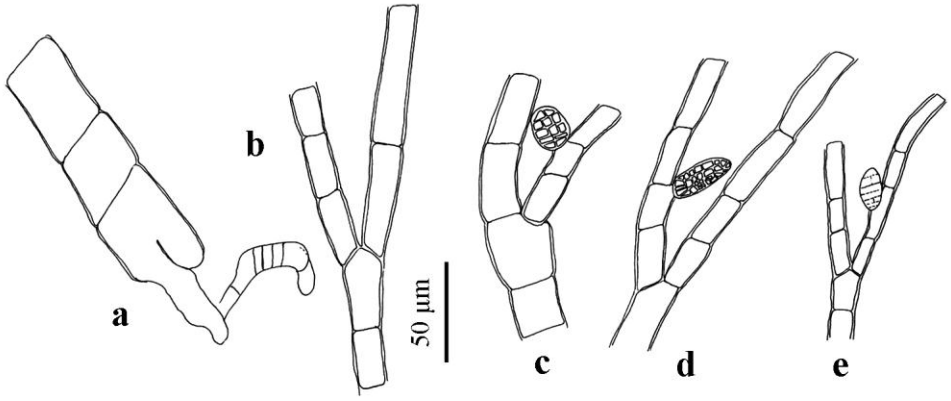

Fig. 14. *Hincksia nizamuddinii* Aisha et Shameel: a, Filament with rhizoidal part; b, Filament with dichotomous branching; c & d, Filaments with lateral, sessile, multiseriate plurilocular sporangia; e, Filament with developing lateral, sessile, multiseriate plurilocular sporangium.

to oblong in shape, 29-40 µm in length, 15-19 µm in breadth, only found on lateral branches of thallus, sessile. Meristematic zones are found at the base of lateral branches. It was found growing epilithic on the sandy rocks of calm water of Buleji and on muddy rocks of Hawkesbay where it showed massive vegetation on the coast, forming blooms.

Type locality: Hawkesbay, Karachi, Pakistan.

Local distribution: Hawkesbay (*Leg.* Aisha 6-2-1993); Buleji (*Leg.* Nizamuddin 20-12-1988).

Genus *Spongonema* Kützing 1849

Thalli forming yellowish brown tuft of 2-4 cm; growing epilithic, also found epiphytic on *Spatoglossum* spp. and *Dictyota hauckiana* Nizamuddin; thallus filamentous; terminal part curved, entangled with one another; uniseriate with series of rectangular cells; phaeoplasts band-shaped; each cell with 1-2 pyrenoids; plurilocular sporangia pedicellate as well as sessile. This is its first record from Indian Ocean. It is represented by following species at the coast of Karachi.

***Spongonema tomentosum* (Hudson) Kützing 1849** (Fig. 15 a-b)

Basionym: *Conferva tomentosum* Hudson 1762:480.

Synonym: *Ectocarpus tomentosum* (Hudson) Lyngbye 1819:132.

References: Børgesen, 1901:414; Hamel, 1931:32; Smith, 1951:83; Kornmann & Sahling, 1977: 1017;

Thalli epiphytic on *Sargassum* spp., *Spatoglossum* spp. and *Cystoseira indica* (Thivy *et* Doshi) Mairh, forming yellowish brown thread like clusters on the host, 2-4 cm high, much branched, entangled with each other and give rope like appearance. Thallus filamentous, uniseriate filaments with quadrato-rectangular cells; cells (23-)34- 57 (-68) µm in length, 23-34 µm in breadth; many discoid phaeoplasts; two pyrenoids in each cell; sparsely, irregularly branched, branches tapering towards the apex, tips acute, forming curved or hook-shaped ends; entangled with other filaments. Unilocular sporangia were not recorded; plurilocular sporangia frequent on main filaments as well as lateral branches, cylindrical to conical, obtuse apex, mostly sessile, (46-)68-114 µm long, 23-34 µm broad. The meristematic zones localized in lateral branches. It was found in drift form and also rowing epiphytically on *Sargassum* spp., *Spatoglossum* spp. and *Cystoseira indica* (Thivy *et* Doshi) Mairh.

Type locality: England.

Local distribution: Manora (*Leg.* Aisha 28-1-1991, 21-1-1992).

Geographical distribution: Pacific Coast and North Atlantic.

Genus *Streblonema* Derbés *et* Solier 1851 :100

Thalli forming endophytic, reddish brown patches; basal portion penetrates into cortex of host; filaments unbranched, erect, growth zones lacking; phaeoplasts band-shaped; few pyrenoids; plurilocular sporangia, cylindrical, directly arise from basal endophytic portion. The genus is represented by following single species at Karachi coast.

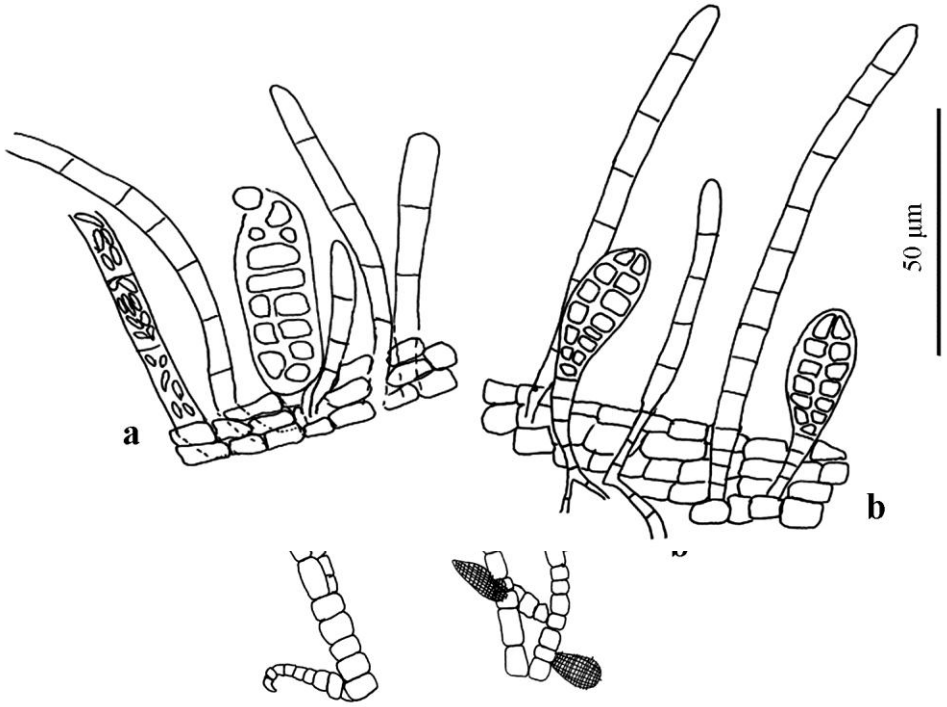

Fig. 15. *Spongonema tomentosum* (Hudson) Kützing: a & b, Habit of the thallus.

***Streblonema fasciculatum* Thuret *in* Le Jolis 1863: 73** (Fig. 16 a & b)

Synonyms: *Streblonema volubilis* Pringshem 1862:13, *Streblonema anioinalum* Setchell *et* Gardner 1922.

References: Hamel, 1931:69; Smith, 1951:90.

It formed reddish brown patches which covered the entire surface of the host. Thallus filamentous, basally endophytic; lower rhizoidal portion penetrated into cortex of the host; erect filaments unbranched; each filament with uniseriate rectangular cells; cells 12-22 (-25) µm in length, throughout same in breadth *i.e*. 6 µm; end cells of each filament large, prominent, (-25) 31-34 µm long, 6 µm broad; phaeoplasts many, band-shaped. Unilocular sporangia were not observed; plurilocular sporangia directly arise from the basal endophytic part, elongated in shape with blunt apex, 31-53 µm in length, 9-12 µm in breadth. Thallus lacks any meristematic zone, growth takes place by apical cell of the filaments. grows as epiphyte on *Spatoglossum* spp. which are found in drifted as well as in benthic form.

Type locality: San Pedro, California.

Local distribution: Manora (*Leg.* Aisha 11-11-1989).

Geographical distribution: California and Australia.

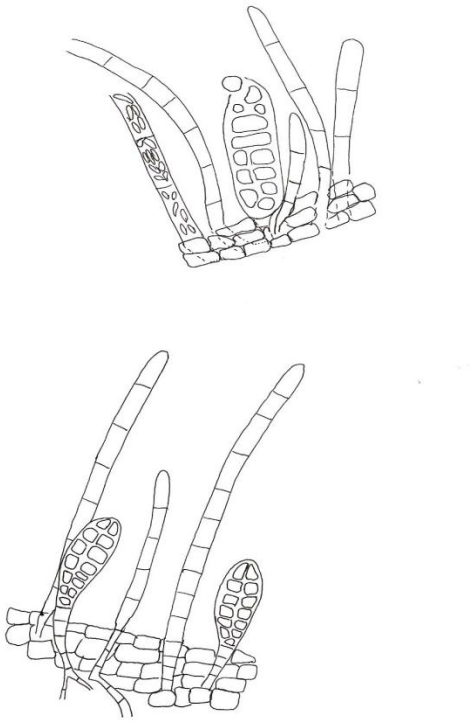

Fig. 16. *Streblonema fasciculatum* Thuret *in* Le Jolis: a & b, Habit of the thallus.

Family Pilayellaceae Pedersen 1984:50

Thallus initially filamentous, branched, monostromatic, becoming parenchymatous as a result of the formation of a few longitudinal divisions; sporangia arise by a simple transformation of vegetative cells; growth by intercalary meristem. Pedersen (1984) aligned the Pilayellaceae with families traditionally placed in the order Dictyosiphonales, but Silva *et al*. (1996) retained it in the order Ectocarpales. The latter practice appears to be more meaningful. This family was represented at the coast of Karachi by a single species *Bachelotia antillarium* (Grunow) Gerloff 1959:38 [=*Ectocarpus antillarum* 1867:46], which has also been described earlier (Aisha & Shameel, 2009).

Genus *Bachelotia* (Bornet) Kuckuck *ex* Hamel 1939

Thalli filamentous, epilithic, yellowish brown in colour; attached to rocks by minute disc-shaped holdfast; filaments branched, opposite or alternate; phaeoplast stellate, single or two in a cell, 1-2 pyrenoids; growth by intercalary meristem; unilocular sporangia intercalary. This genus is being recorded for the first time from the coast of Pakistan. Its following species occurs at Karachi coast.

Bachelotia antillarum (Grunow) Gerloff 1959:38 (Fig. 17)

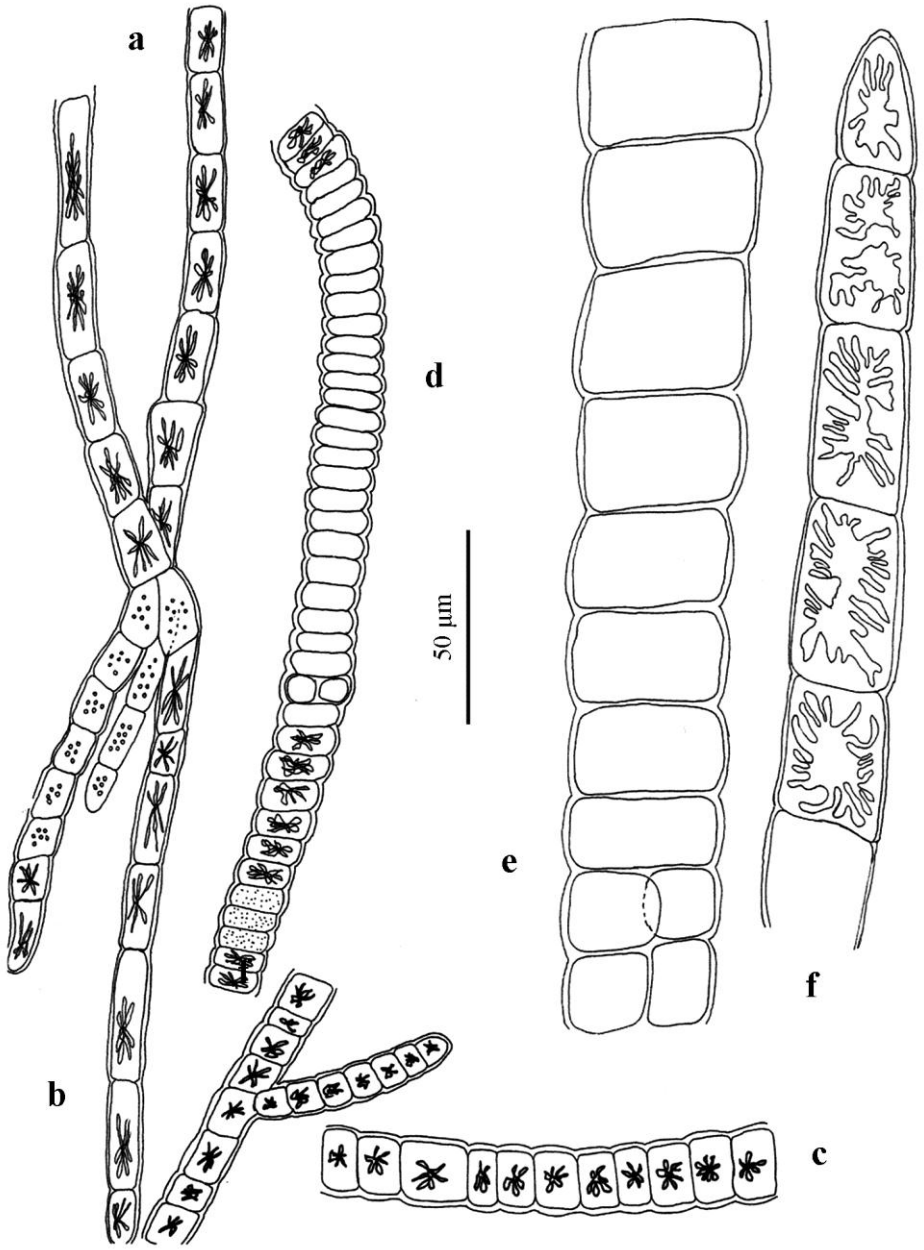

Fig. 17. *Bachelotia antillarum* (Grunow) Gerloff. a, Vegetative filaments with basal part; b, Lateral branch; c, A part of filament; d, Filament with reproductive organs; e, Enlarged view of filament with reproductive organs; f, Enlarged view of apical part.

Basionym: *Ectocarpus antillarum* Grunow 1867: 46.

References: Børgesen, 1920: 43; Hamel, 1937:9; Lindauer *et al.*, 1961: 141; Earle, 1969: 129; Womersely, 1987: 30; Krishnamurthy & Joshi, 1970: 9; Silva *et al.*, 1996: 571.

Thalli 2-3 cm high, rough to touch and give *Sphacelaria* like appearance, filamentous, sparsely to irregularly branched, epilithic on stones, attached to substratum by hepteron like filamentous structure. Filamentous erect portion with rectangular to elongated cells, arranged uniseriately, 34-80 µm in length, throughout same diameter *i.e.* 34 µm; cell wall 1.5-3.0 µm thick, each cell with a single star-shaped or stellate phaeoplast, sometimes two halves joint centrally with one another.Reproductive organs intercalary, only unilocular sporangia present, plurilocular sporangia not observed in these specimens. Each filament with many intercalary, small cells, indicating that growth takes place by intercalary meristem. It grows epilithic on the stones in shallow pools near upper littoral zone.

Type locality: Guadaloupe, West Indies.

Habitat ecology: It grows epilithic on the stones in shallow pools near upper littoral zone.

Geographical distribution: West Indies, Gulf of Mexico, France, India, South Africa, Tanzania and Australia.

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